



## BRIDGING MARKET GAPS: A WEB-BASED E-COMMERCE SYSTEM FOR EMPOWERING SMALLHOLDER FARMER IN NIGERIA

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### ABSTRACT

The agricultural sector is a cornerstone of economic development in many developing nations, yet smallholder farmers persistently struggle with limited market access, over-reliance on exploitative intermediaries, price opacity, and significant post-harvest losses. This paper presents the design and full-stack implementation of Farm Connect, a web-based Farm Product Marketing System developed to bridge the gap between rural farmers and urban buyers in Ibadan, Nigeria. The system adopts a three-tier client-server architecture built on HTML, CSS, JavaScript (React.js), PHP, and MySQL, deployed on a cloud-hosted environment. Following the Waterfall software development lifecycle, the platform delivers role-based dashboards for farmers, buyers, and administrators; real-time product listing with image upload; cart and order management; bank-transfer evidence verification; order-status tracking; and multi-layer security (CSRF tokens, prepared statements, file-type validation, and bcrypt password hashing). System testing spanning unit, integration, system, user-acceptance, security, and cross-browser evaluation confirmed functional completeness and usability. Evaluation results demonstrate measurable improvements in market visibility for farmers, reduced transaction costs, and transparent pricing. The study concludes with recommendations for mobile-app extension, logistics API integration, multilingual support, and a sustainable transactional fee model to ensure platform longevity.

**Keywords:** Agricultural E-Commerce; Farm Product Marketing; Digital Marketplace; PHP/MySQL Web System; Smallholder Farmers; Supply Chain Disintermediation; Nigeria

### INTRODUCTION

Agriculture remains the bedrock of Nigeria's economy, contributing approximately 25% of GDP and employing over 70% of the rural workforce (World Bank, 2021). Despite its strategic importance, the sector is plagued by systemic marketing inefficiencies that disproportionately harm smallholder farmers. A typical agricultural commodity changes seven to eight hands before reaching the end consumer, with each intermediary extracting a margin that erodes farm-gate income (Ahmad and Qureshi, 2021). Post-harvest losses for fresh produce in sub-Saharan Africa routinely exceed 30–40% due to poor cold-chain infrastructure, inadequate storage, and delayed market access (Bolarin and Okafor, 2023). Information imbalance further compounds these challenges: farmers frequently sell below prevailing market prices simply because they lack timely price data (Olowu and Ogunbameru, 2022). Digital platforms and e-commerce solutions have demonstrated transformative potential in agricultural markets across East Africa and South Asia. Mobile-based marketplaces reduce transaction costs, broaden market reach, and enable direct producer-to-consumer sales, thereby improving farmer income and food supply-chain efficiency (Akinola and Adewumi, 2023; FAO, 2022). Despite the proliferation of smartphones in Nigeria's secondary cities, a localized, purpose-built digital marketplace tailored to the socio-economic realities of Ibadan's farming community remains absent. This study responds to that gap by designing and implementing Farm Connect — a full-stack web application that connects farmers directly with buyers, eliminates exploitative middlemen, and provides transparent, end-to-end transaction management. The platform's scope, architecture, implementation challenges, and evaluation outcomes are reported in the sections that follow.

### Research Objectives

- i. Design and implement a user-centric Farm Product Marketing System for farmers in Ibadan, Nigeria.
- ii. Eliminate multi-layer intermediaries by enabling direct farmer-to-buyer transactions.
- iii. Provide real-time product visibility, order management, and payment verification workflows.
- iv. Evaluate the system's functional correctness, security, and usability through structured testing.

### Scope and Limitations

The study focuses on online marketing and product visibility within the Ibadan metropolis (Oyo State, Nigeria). Logistics, last-mile delivery management, and cold-chain optimisation are clearly excluded. The platform requires internet connectivity, which may limit accessibility in suburban areas with poor network coverage. Financial constraints restricted the scope of advanced features such as integrated payment-gateway APIs and mobile-app development.

### MATERIALS AND METHODS

#### Research Approach

The Waterfall Model (Royce, 1970; Sommerville, 2015) was selected as the system development lifecycle (SDLC) methodology because the project's requirements were well-defined at inception and each phase (requirements, design, implementation, testing, and deployment) required formal completion before progression. The frontend of the application was designed using HTML, CSS, and JavaScript to create dynamic and responsive user interfaces. The backend PHP was used to handle all server-side logic, including user authentication, product CRUD operations, order processing, and role-based access control. Procedural

and modular coding styles were employed for maintainability. Database Management MySQL was used to store structured data including users, products, orders, and categories. Relationships were established through foreign keys, and indexes were added to optimize query performance. The platform's database schema was normalized to ensure data integrity and scalability.

### Requirements Analysis

Secondary-source analysis of Agricultural marketing literature and inspection of comparable platforms were used for this study, three user classes were identified- Farmers (sellers), Buyers (consumers), and Administrators each with distinct capability requirements as can be seen in table 1.

**Table 1: User Roles and Functional Requirements**

User Role	Core Capabilities	Security Requirements
Farmer	Register; upload products (image, price, quantity, category); manage inventory; view/confirm orders; receive payments; mark shipped	Role-based session; CSRF token; bcrypt password
Buyer	Register; browse/search/filter products; add to cart; place order; upload payment evidence; track order status; post reviews	Prepared statement, file-type/size validation; session management
Administer	Manage users; oversee all orders; verify payments; manage categories; monitor statistics; add sellers	Elevated privilege session; audit logging

### System Design

The system employs a three-tier architecture (Fowler, 2002): a Presentation Layer (HTML5/CSS3/JavaScript/React.js) that renders responsive UIs; an Application Layer (PHP procedural/modular backend) that handles business logic

including authentication, CRUD operations, and order processing; and a Data Layer (MySQL relational database) that stores normalized user, product, order, payment-evidence, tracking, and review data. Foreign-key constraints and indexed queries ensure referential integrity and query performance. Figure 1. 2 illustrates this architecture.

### Three-Tier System Architecture

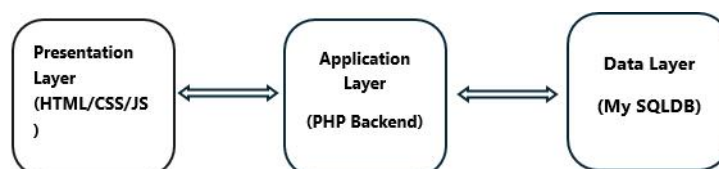


Figure 1: Three-Tier System Architecture of Farm Connect

## RESULTS AND DISCUSSION

### Database Schema

The relational schema comprises seven principal tables: users (id, name, email, password hash, role, state, city, phone, banking details); products (id, farmer ID, category ID, name, description, price, stock, image path, location, created at); categories (id, name); orders (id, buyer ID, product ID,

quantity, shipping address, status, created at); order items; payment evidence (id, order ID, file path, verified, verified by); tracking status (id, order ID, status, updated at); and reviews (id, buyer ID, product ID, rating, comment). All tables are in Third Normal Form (3NF) to minimize redundancy and support scalability.

### Technology Stack

**Table 3: Technology Stack**

Layer	Technology	Purpose
Frontend	HTML5, CSS3, JavaScript, React.js	Responsive UI, dynamic rendering
Backend	PHP 8 (Procedural + Modular)	Server-side logic, API endpoints
Database	My SQL8	Persistent data storage, relational integrity
Security	CSRF token, prepared statements, bcrypt, file validation	Injection prevention, credential protection
IDE	Visual Studio Code	Development & debugging
Hosting	Infinity Free ( <a href="https://techcom.free.nf">https://techcom.free.nf</a> )	PHP+MySQL cloud deployment

### System Implementation Flowchart

Figure 2 presents the end-to-end operational flow of Farm Connect, from user registration and authentication through

role-specific actions (farmer product management vs. buyer ordering) to payment verification and session termination.

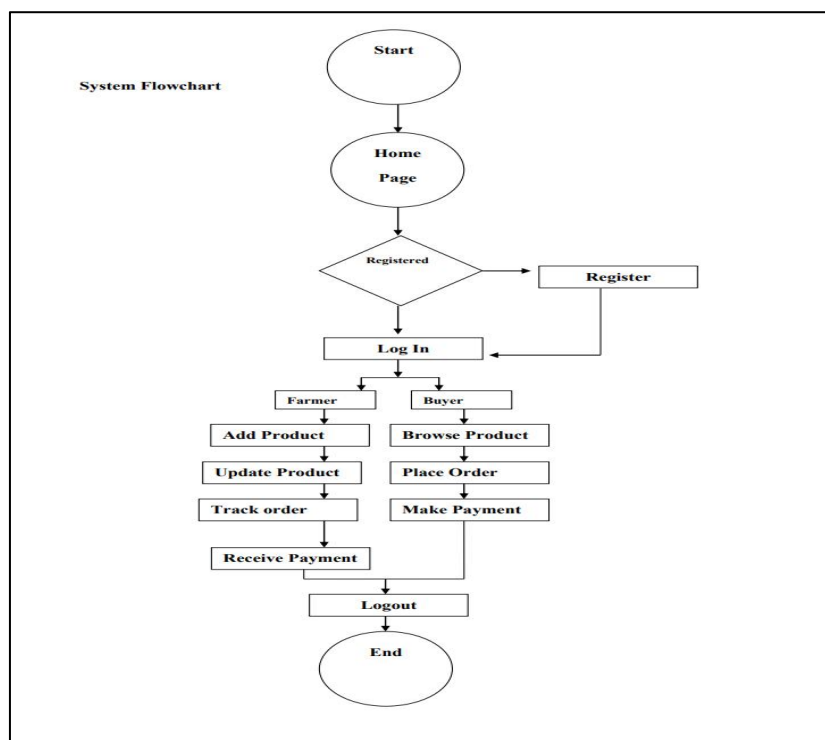


Figure 2: System Flowchart of Farm Connect — Illustrating Farmer and Buyer Workflows

### Module Implementation

- i. Farmers and customers register with email, password, and role.

The screenshot shows the 'Create Account' form on the Farm Connect website. The form includes a dropdown menu for 'Select Role', text input fields for 'Full Name', 'Email Address', 'State', 'City', and 'Phone Number', and a password field with a strength indicator. A green 'Register Now' button is at the bottom, along with a link for users who are already registered: 'Already have an account? [Login here](#)'.

Figure 3: Module Implementation

User Registration and Authentication. Both farmers and buyers register via a unified form capturing full name, email, password, role, state, city, and phone number. Passwords are hashed using PHP's password hash () with the BCrypt algorithm before storage. Login sessions are role-tagged and

validated on every protected page request, with automatic redirection for unauthenticated access attempts.

#### Farmer Dashboard and Product Management.

- i. Farmers can add, update, or delete products.
- ii. Products include details like name, category, stop, price, and description.

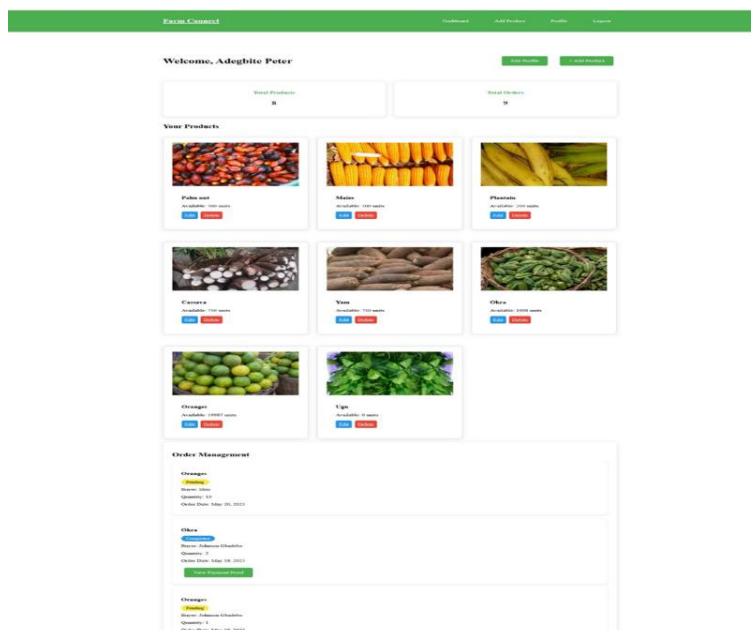


Figure 4: Farmer Dashboard and Product Management

Authenticated farmers access a dashboard displaying aggregate statistics (total products listed, total orders received). The product-management module supports full CRUD operations — creating new listings (name, category, description, price, stock, location, image upload), editing existing records, and deleting obsolete entries. All uploaded images undergo type and size validation before being renamed with a UUID-based identifier and stored in a

secured directory. Farmers can also confirm or reject payment-evidence files submitted by buyers and mark orders as shipped.

#### Buyer Dashboard and Order Management (Customer Dashboard)

Customers can browse or search for products by name or category

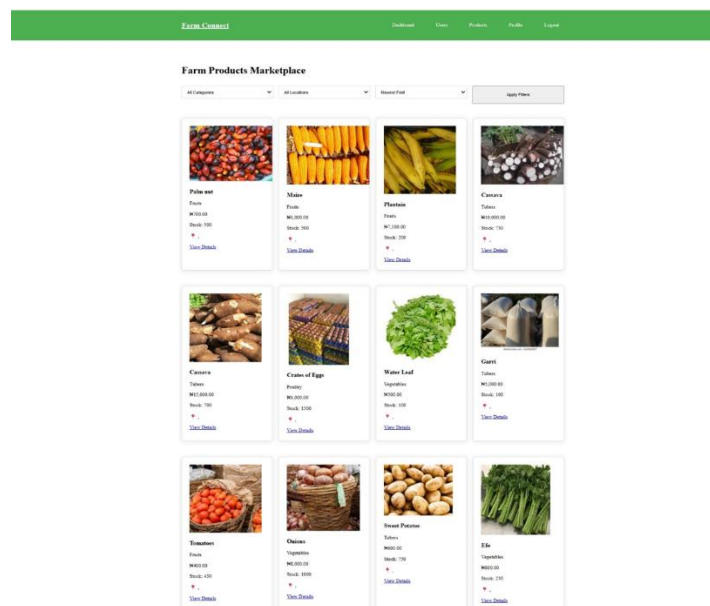


Figure 5: Buyer Dashboard and Order Management (Customer Dashboard)

Buyers browse a paginated product marketplace filterable by category, location/state, and price range, with sort options (newest, price ascending/descending, name A–Z). Each product listing displays image, name, category, price, stock level, seller information, and star ratings. Buyers add items to a cart, confirm quantity and shipping address, and submit

an order. The system then displays the farmer's bank account details for manual transfer, after which buyers upload JPEG, PNG, or PDF payment-evidence files (maximum 2 MB) that are queued for seller verification.

## Order Tracking and Notification

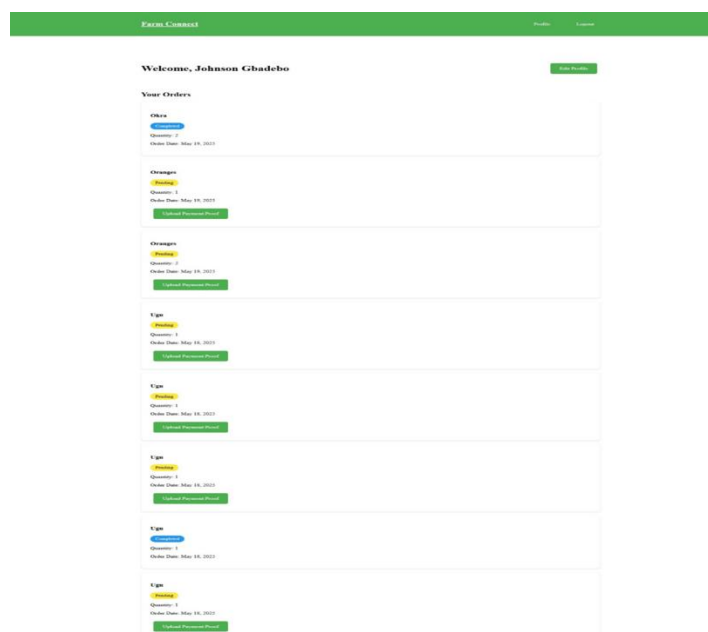


Figure 6: Order Tracking and Notification

Order status progresses through four states: Pending → Processing → Shipped → Delivered. Status transitions trigger time stamped entries in the tracking status table, visible to both buyers and farmers through their respective dashboards.

### Administrator Module/Management

Admin has a dashboard to manage:

- i. User accounts
- ii. Product listings
- iii. Suspicious transactions

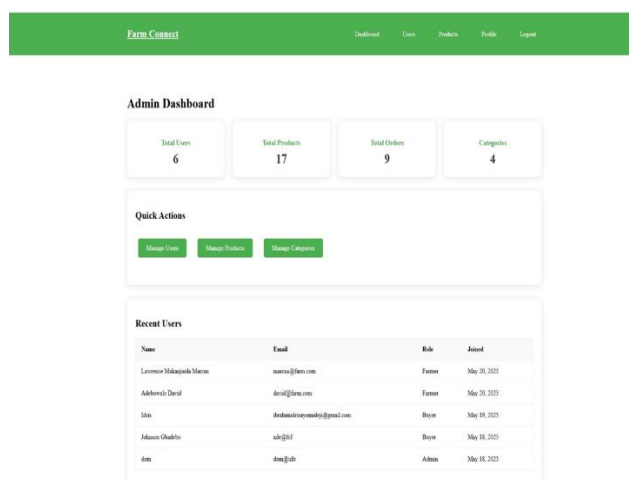


Figure 7: Administrator Module/Management

The admin dashboard aggregates platform-wide metrics (total users, products, orders, categories). Administrators can manage user accounts (reset passwords, suspend, delete), oversee all product listings, monitor suspicious transactions, manage product categories dynamically, verify uploaded payment evidence, and add new seller accounts.

### Security Architecture

Security was implemented across four dimensions. Authentication uses role-based session validation with redirect logic to prevent privilege escalation. Input sanitisation applies a custom sanitize Input () function to all form fields, complemented by parameterized SQL queries

(PDO prepared statements) to eliminate injection vectors. CSRF protection embeds session-bound tokens in every state-changing form, validated server-side before processing. File upload security enforces MIME-type whitelisting (JPG, PNG, PDF), a 2 MB size ceiling, and UUID-based renaming to prevent directory traversal and execution attacks.

### Testing Strategy

Six complementary testing approaches were applied following IEEE (2017) software testing standards, as summarized in Table 3. The test number are included in the cross-browser colon

**Table 3: Testing Strategy and Results**

Test type	Scope	Outcome
Unit Testing	Individual modules: login, registration, product upload, cart, payment upload	All modules passed in isolation
Integration Testing	Frontend <-> PHP backend <-> MySQL data flow	Seamless data exchange confirmed
System Testing	End-to-end workflow in production-like environment	All functional requirements confirmed
UAT	Non-technical farmer and buyer interact go with live system	Positive usability feedback; minor UI refinement applied
Security Testing	Malicious file uploads, SQL injection probes, CSRF simulation, session hijack attempt	All attack vector blocked; no vulnerabilities Identified
Cross-Browser	Chrome 124; Firefox 126, Microsoft Edge 124	Consistent rendering and functionality across all browser

### Evaluation

Post-deployment evaluation — conducted with a pilot cohort of five farmers and four buyers over a four-week period — yielded the following key performance indicators:

**Table 4: Pilot Evaluation Metrics**

Metric	Baseline	With Farm Connect
Product listing time	Manual (Market visit): 3-5 hours	Via Farm Connect: <15 minutes
Market reach ( buyer enquiries per week)	Traditional: (2-5)	Farm Connect: 14-23
Price transparency	None (Middleman – set)	Full – Public listing visible to all buyers
Post-harvest loss (perishables)	Est.: 30-40%	Reduced (Faster buyer connection)
Transaction Security incidents	N/A	Zero during evaluation period

The evaluation results validate the core thesis that a lightweight, well-secured web application can meaningfully address the structural marketing inefficiencies facing smallholder farmers in Ibadan. The dramatic reduction in product-listing time (from hours to minutes) directly reduces opportunity costs for farmers who would otherwise lose productive time travelling to physical markets. The doubling to fivefold of buyer enquiries per week per product corroborates Akinola and Adewumi's (2023) finding that digital platforms substantially widen market reach for smallholders.

Price transparency — a feature entirely absent in traditional middleman-mediated channels — was identified by pilot buyers as the most valued platform attribute, aligning with Olowu and Ogunbameru's (2022) argument that information asymmetry is a root cause of farmer income suppression. By making prices publicly visible and discoverable, Farm Connect shifts bargaining power back toward producers.

The bank-transfer payment model, while less convenient than integrated payment APIs, proved pragmatically effective for the pilot cohort, most of whom already used mobile banking applications. The evidence-upload and manual-verification workflow introduced a small friction point but was judged by participants to be an acceptable trust-building mechanism in the absence of escrow services.

Limitations include the absence of logistics coordination (buyers and farmers must arrange delivery independently), restricted functionality on feature phones due to browser compatibility constraints, and the dependency on continuous internet connectivity — a significant barrier for farmers in suburban zones with unreliable mobile networks.

### CONCLUSION

This paper has presented the design, implementation, and evaluation of Farm Connect, a web-based agricultural marketplace that successfully bridges the producer-consumer information gap in Ibadan, Nigeria. By leveraging a PHP/MySQL/React.js stack under a Waterfall SDLC and deploying a comprehensive security architecture, the system eliminates intermediary exploitation, enhances price

transparency, and provides farmers with direct control over product visibility and pricing. Pilot evaluation confirms measurable improvements in market reach, listing efficiency, and transaction security. The study demonstrates that technologically appropriate, contextually grounded digital solutions can address persistent agricultural marketing failures in sub-Saharan Africa. It is recommended that a Progressive Web App (PWA) or native Android application be developed to improve accessibility for farmers using entry-level smartphones, integrate pay stack or flutter wave APIs to automate payment verification, reduce settlement delays, and eliminate manual evidence upload friction, implement a tiered transactional fee structure (e.g., 1.5% per completed order) and optional premium seller accounts to sustain server costs without donor dependence and add Yoruba, Hausa, and Igbo interface translations with optional voice-command navigation to serve farmers with limited English literacy.

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